EKI Electronic Kits International Inc.

Mr. CIRCUIT®

Solderless Electronic Kit Series

LAB KIT A0

INTRODUCTION

The Mr. Circuit Solderless Electronic Kit Series was created to provide science and electronic students, and hobbyists with a meaningful and exciting hands-on introductory course in electronics. No previous knowledge about electronics is required. This series is made of 30 experiments : Lab Kits A1 to A30, and this introductory Lab Kit A0. The thirty experiments will stimulate students minds and increase their science and electronic knowledge as they build solderless electronic projects using integrated circuits, light emitting diodes (LEDs), transistors, diodes, photocells, and other electronic components.

Each Lab Kit comes in its own box and contains all the components and instructions to assemble that specific project. This Lab Kit (Lab Kit A0) contains the Solderless Circuit Board that you will use to assemble all the Lab Kits and three introductory lessons. The following is a list of all the Lab Kits in the Mr. Circuit Solderless Electronic Kit Series.

List of Mr. Circuit Lab Kits

Lab Kit A0: Solderless Circuit Board / Introductory Lessons

Lab Kit A1: How A Resistor Works
Lab Kit A2: How A Potentiometer Works
Lab Kit A3: How A Photocell Works
Lab Kit A4: How A Capacitor Works
Lab Kit A5: How A Speaker Works
Lab Kit A6: How A Diode Works
Lab Kit A7: How An SCR Works
Lab Kit A8: How An NPN Transistor Works
Lab Kit A9: How A PNP Transistor Works
Lab Kit A10: Transistor Oscillator
Lab Kit A11: Blinking LED
Lab Kit A12: Burglar Alarm
Lab Kit A13: Automatic Night Light
Lab Kit A14: DC To DC Power Supply
Lab Kit A 15: Electronic Metronome
Lab Kit A16: Electronic Motorcycle
Lab Kit A17: Railroad Lights
Lab Kit A18: Variable Speed Lights
Lab Kit A19: Continuity Tester
Lab Kit A20: Audio Generator
Lab Kit A21: Electronic Police Siren
Lab Kit A22: Wake-up Alarm
Lab Kit A23: Variable Timer
Lab Kit A24: Moisture Detector
Lab Kit A25: Code Oscillator
Lab Kit A26: Audible Water Detector
Lab Kit A27: English Police Siren
Lab Kit A28: Electronic Canary
Lab Kit A29: Space Machine Gun
Lab Kit A30: Ultrasonic Pest Repeller

The Mr. Circuit Solderless Electronic Kit Series was designed in a progressive order of complexity, therefore we recommend that the beginner follow the order of the lessons and projects (Lab Kits), but it is not a requirement. You can choose any Lab Kit you would like and construct it by following its instructions.

Now you are ready to start working on Lesson 1: Basic Electronic Theory.

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LESSON 1
Basic Electronic Theory

MATTER

Everything you see around you is made of "matter". The desk, pen, paper, water, etc., even yourself!. **Matter is something that has mass and takes up space.** It can be found in three states: SOLID, LIQUID, and GAS. At this point you might ask, what is matter made of?

Answer: ELEMENTS

Matter is made up of elements, which are substances found naturally in the universe, such as carbon, oxygen, silver, gold, etc. There are approximately 104 different known elements in the universe. These elements when chemically mixed together in specific combinations make-up...EVERYTHING. Now, the next question, what are the elements made of?

Answer: ATOMS

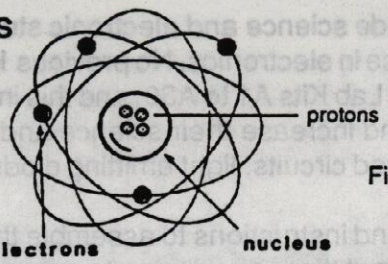


Fig. 1

Each element is made up of "atoms", as the one shown in fig. 1. Atoms have a central core, called a NUCLEUS, filled with positively (+) charged particles known as PROTONS. Surrounding the nucleus, in several orbits, are negatively (-) charged particles called ELECTRONS. All atoms are arranged in this way, regardless of whether they constitute an element of hydrogen or gold. The only important difference is the number of protons and electrons each atom has. For example, hydrogen has one electron, while gold has thirty-nine.

PENCIL EXERCISE # 1.

Draw an atom and label its parts.

THE ELECTRONS AND THE ELECTRIC CURRENT

Now you can say, "Okay, I understand that everything is made up of atoms, and that atoms are made up of protons inside a nucleus with electrons running around it, but ...what does this have to do with electronics?" By definition, electronics is a part of physics that studies the movement of electrons. Electric current, is the movement of millions of electrons through a conductor (wire).

When you connect a lamp to a battery as shown in fig. 2, the lamp lights up, because electric current circulates through it.

What actually happens is: in the negative side of the battery you have millions and millions of electrons in excess and in the positive side of the battery you have a lack of electrons. Therefore, electrons flow from the negative terminal of the battery to the positive terminal, passing through the lamp. This flow of electrons, called "electric current", causes the lamp to light up.

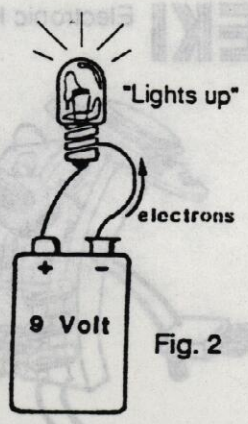


Fig. 2

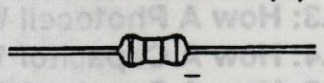
PENCIL EXERCISE #2

1) In the negative side of the battery, there are millions and millions of _____.
2) In the positive side of the battery, you have atoms with a _____ of electrons .
3) When you connect a lamp or any other conductive material across the terminals of a battery, electrons will flow from the _____ terminal to the _____ terminal of the battery. This flow is called _____ current.

Now that you know that electronics is the part of the physics that studies the movement of electrons, and that an electric current is the movement of millions and millions of electrons, from a negative source to a positive source, you are ready to go to Lesson 2, called: The Resistor Color Code.

LESSON 2
Resistor Color Code

RESISTORS, RESISTANCE & OHMS (Ω).



Resistors are one of the most popular and fundamental electronic components. You will always find them in electronic circuits. Resistance is the opposition to the current flow. We often need resistance to control current flow . Each resistor contains a certain amount of resistance. Resistance is measured in ohms(Ω). For example, a resistor of 10,000 ohms would provide much more opposition to a current flow than a resistor of 1000 ohms. So the higher the number of ohms, the higher the resistance, the fewer electrons flow through the resistor.

PENCIL EXERCISE 1.

1. Resistance is the _____to current flow.
2. Each resistor contains a certain amount of_____.
3. Resistance is measured in_____.
4. A resistor of 20,000 ohms will provide_____opposition to the current flow than a resistor of 5,000 ohms.

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Two or more wires or leads plugged into anyone of the five holes will be connected together. There are 60 groups of five holes.

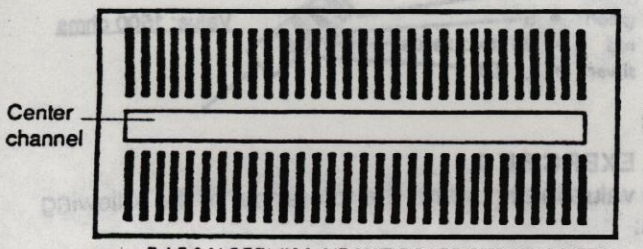

Fig. 2

Under side view of Soldelress Circuit Board showing metal strips which connect each group of five holes

A center channel divides the board in half. Integrated Circuits can be straddled across this channel as shown in fig. 3. Also note that numbers and letters were printed on the board to help identify each hole during the construction process.

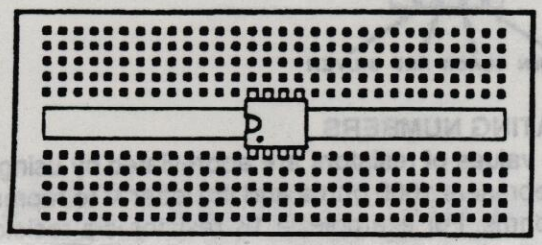

Fig. 3

In order to learn how to use the Solderless Circuit Board do the following experiment. Let us say that we want to build a simple circuit to light up an LED, like the one shown in fig. 4.

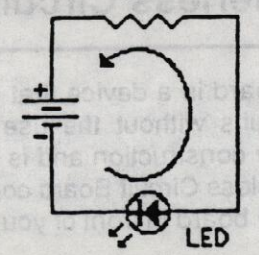

Fig. 4

In this circuit an electric current flows from the negative terminal of the battery to the positive terminal, passing through the LED and the resistor. As current flows through the LED, it illuminates.

One way to build this circuit is by soldering the leads of the components to one another, as shown in figure 5.

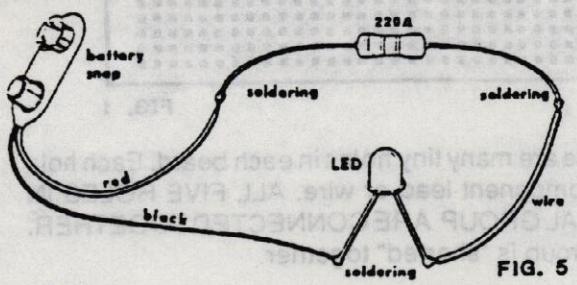

FIG. 5

Or, the same circuit can be constructed, easily and neatly, by using a solderless circuit board, as shown in fig. 6.

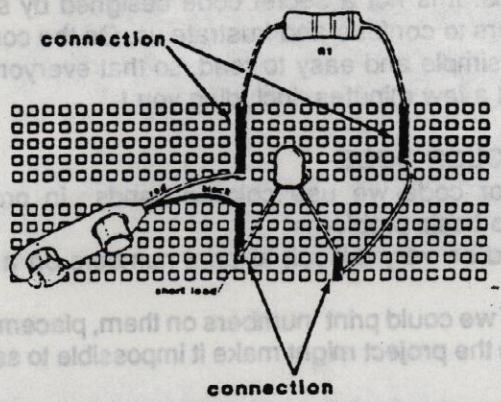

Fig. 6

In this case, the leads of the components are connected to one another by the metal strips of the solderless circuit board, as shown in fig. 6. REMEMBER, WIRES THAT MUST BE CONNECTED TOGETHER MUST BE INSERTED INTO HOLES OF THE SAME VERTICAL COLUMN.

Now, using the solderless circuit board and the parts, build the circuit of fig. 6.

Take special care while installing the LED to put the short lead in the right direction. Once you have the circuit assembled, connect a battery to the battery snap and the LED should light up. Now, make a little change in the circuit. Pull out the red wire of the battery snap from its original position and insert it in the hole shown in figure 7.

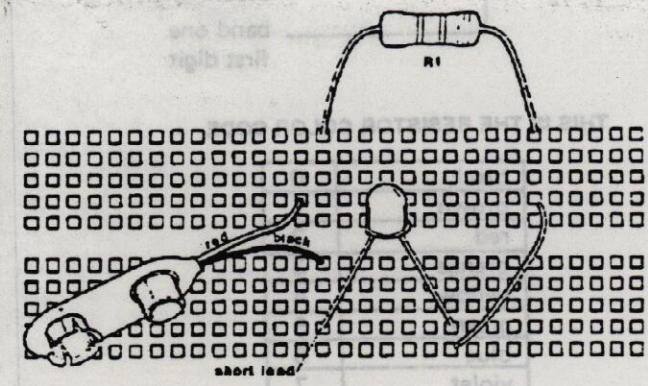

Fig. 7

What happened to the LED when you made that change?_____

Explain why. _____

_____

_____

The LED went out because in the circuit shown in fig. 7 there is no connection between the red wire of the battery snap and resistor R1.

Therefore, again, always remember, "WIRES THAT NEED TO BE CONNECTED TOGETHER MUST BE INSERTED INTO THE SAME VERTICAL COLUMN OF HOLES".

NOTE: Never connect the LED directly to the battery. It will destroy the LED

Now you are ready to work on more Lab Kits.

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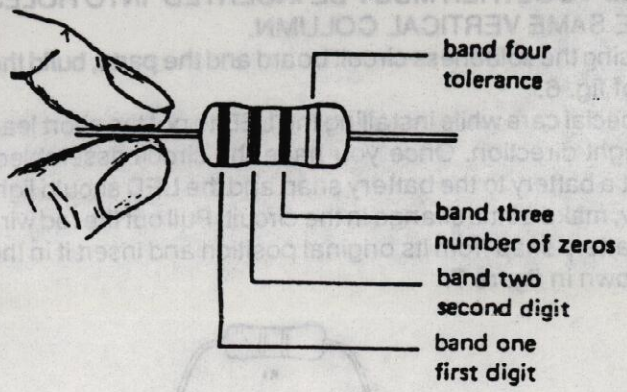
THE RESISTOR COLOR CODE

The resistor color code is a method of indicating the resistance value in ohms. It is not a secret code designed by sinister cryptographers to confuse and frustrate us. On the contrary, it was made simple and easy to read, so that everyone can learn it in just a few minutes, including you !

WHY THE COLOR CODE

With the color code we use colored bands in order to overcome two basic problems:
ONE: It would be very difficult to print numbers on a small resistor.
TWO: Even if we could print numbers on them, placement of the resistor in the project might make it impossible to see the numbers.
The color coded bands that go entirely around the resistor seem to solve these two problems. When reading the color code, the resistor should be held with the gold (or silver) band on the right, as shown in the next picture.



THIS IS THE RESISTOR COLOR CODE

black	0
brown	1
red	2
orange	3
yellow	4
green	5
blue	6
violet	7
gray	8
white	9

Each color stands for a particular number. For example, red equals two. When reading the color code remember:
-The FIRST BAND always represents A NUMBER.
-The SECOND BAND always represents A NUMBER.
-The THIRD BAND always represents the NUMBER OF ZEROS to be added to the two preceding numbers. (If the third band is black, no zeros are added).
-The FOURTH BAND represents the TOLERANCE value. This band is usually GOLD, 5%; or SILVER 10%.

Tolerance means the precision or exactness of the value of the resistor. For example, resistors with a gold band have an actual value plus or minus 5% of what the color code indicates, due to differences in manufacturing.

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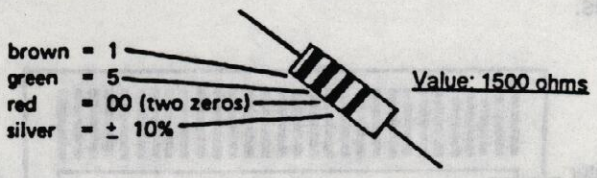
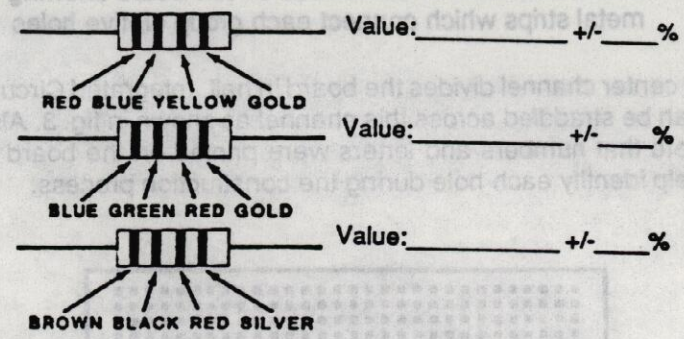
EXAMPLE.

What is the value in ohms, and the tolerance of the following resistor ?



PENCIL EXERCISE 2.

Give the value in ohms and the tolerance, of the following resistors:



ABBREVIATING NUMBERS

Usually the values of resistors are abbreviated by using the letter K to represent 1000 ohms and the letter M to represent 1,000,000 ohms. For example, a 1K resistor is a resistor of 1000 ohms. A 3.3K resistor is a resistor of 3300 ohms. A 2M resistor is a 2,000,000 ohm resistor.

LESSON 3
Using The Solderless Circuit Board

The Solderless Circuit Board is a device that allows you to assemble electronic circuits without the use of solder. It makes for quick and easy construction and is thus ideal for experimentation. A Solderless Circuit Board comes supplied in this Lab Kit A0. Lay the board in front of you, as shown in fig. 1.

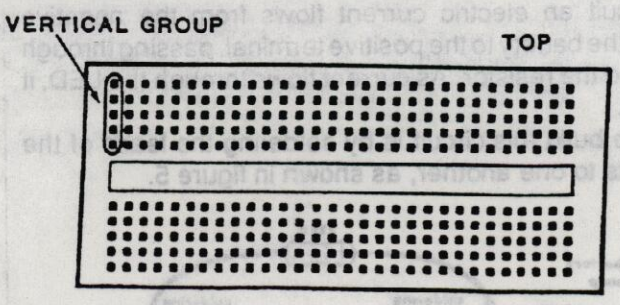


FIG. 1

Notice that there are many tiny holes in each board. Each hole will accept a component lead or wire. ALL FIVE HOLES IN EACH VERTICAL GROUP ARE CONNECTED TOGETHER. Each vertical group is "shorted" together.